

REMARKS

This application is amended in a manner to place it in condition for allowance at the time of the next Official Action

Claims 113, 114 and 124-126 are amended. Support for the amended claims may be found generally throughout the specification, for example, at page 3, lines 9-11, page 6, lines 5-9, pages 7, lines 17-18, page 9, lines 14-29, and the Examples.

Claims 113-126 remain pending in the application.

Claims 114-126 were rejected under 35 U.S.C. 103(a) as being unpatentable over MURPHY US 2002/0010291 ("US 291"). That rejection is respectfully traversed, for the following reasons.

The Official Action recognized that US 291 does not disclose that the functionalized and nonfunctionalized liquids react with each other or that they can be extracted from each other by solvent extracts, i.e., that they are dissolved in each other and form a homogeneous phase. The Official Action also recognized that US 291 does not disclose that the functionalized salt is recyclable. Nevertheless, the Official Action concluded that because the functional groups of US 291 were considered to be similar with those claimed, the functionalized salt of US 291 must therefore share the same properties.

Preliminarily, applicants note in response that, in addition to the acknowledged shortcomings of US 291, the general synthesis conditions of US 291 [0062] are not described in a manner to disclose or suggest(A) a functionalized salt which is a

recyclable soluble reaction support and (B) an ionic liquid and a functionalized salt in a homogeneous solution, as recited in independent claims 114 and 124.

A. A recyclable soluble reaction support

The position of the Official Action was that the catalyst and the ionic liquid can be separated and recycled : *"it is well known in the art that the bond between a functional group and the catalyst or scavenger are reversible and thus the ionic liquid can be recycled by removing the catalyst or scavenger."*(page 3).

However, the Official Action provided no evidence showing how this may be accomplished, and US 291 suggests that the catalysts are not recyclable for at least the following four reasons:

1) The catalysts of the examples are compounds, such as [EMIM][AlCl₄⁻] and EtAlCl₂ in examples 1 and 2, respectively.

The only way to separate the catalyst from the ionic liquid would be to add water in order to form a biphasic system and extract the catalyst. However, it is well known that chloroaluminates are destroyed by water (this is indeed a severe limitation of this kind of chloroaluminates ionic liquids). Any attempt to recover the catalyst upon water extraction would have resulted in a total destruction of the catalyst and the ionic

liquid. Furthermore, it would have even been difficult to recover the starting imidazolium chloride.

2) US 291 discloses other catalysts may be linked to the ionic liquid [0061].

In order to perform cross-coupling reactions such as Suzuki, Heck, Negishi or Stille, one skilled in the art typically uses palladium complexes where the metal center is stabilized by electron donating ligands, most commonly trialkyl or aryl phosphines.

The most straightforward way to bond these ligands to an ionic liquid would be to covalently link one of the substituents of the phosphine to either the cation or the anion of the ionic liquid, and then to generate the palladium complex. Such a synthesis is not straightforward to the one skilled in the art, and the document US 291 does not teach how to link covalently a palladium ligand to an ionic liquid.

3) Assuming that one could find a way to prepare an ionic liquid to which a catalyst is covalently linked, breaking such a covalent bond requires a sufficient amount of energy (e.g. heat) or a chemical reaction, which might break down the catalyst.

US 291 does not teach how to break this link in order to recover the catalyst and the ionic liquid separately, without partially or totally damaging the catalyst. A supported synthesis

does not show any interest if the support recycling induces the degradation of the grafted compounds.

It is also clear that the catalyst (if it were to still have catalytic properties) recovered after breaking the covalent bond between the catalyst and the ionic liquid, would be (at best) the same as the catalyst before it was grafted on the ionic liquid, and very probably degraded. Thus, US 291 does not teach modification of the ionic liquid supported compounds to give a desired useful product.

4) In the scope of the document US 291, it is not required to break this bond.

Indeed, to the contrary US 291 suggests that it is a great advantage that the catalyst remains bound to the ionic liquid cation, so that the catalyst can be easily separated from the reaction mixture and recycled, which is desired by US 291. Thus, one of ordinary skill in the art would not have been motivated to separate the catalyst from the support.

For the reasons discussed above, Applicants respectfully disagree with the position of the Official Action that assumes that in US 291, the bond between the ionic liquid and the catalyst is reversible. Reversible implies that the catalyst remains active. There is no indication of how to create or remove the bond between the ionic liquid and the catalyst, and if the

catalyst would withstand such treatment. No example of such supported catalyst is provided. Even if one with ordinary skill in the art succeeds in preparing an ionic liquid with a covalently bound catalyst, he would not be motivated to break it because the catalytic activity would then surely be lost.

B. A homogenous solution

The position of the Official Action was that previously filed arguments with respect to the failure of US 291 to disclose a homogenous composition were not convincing (page 4). The Official Action stated that *"the intended use of the taught composition does not patentably distinguish the taught composition over the claimed composition."*(page 3).

However, the present claims are directed to a liquid matrix and functionalized salt forming a homogenous phase, which is physical characteristic of the claimed composition and not a mere statement of intended use.

Indeed, the present claims have been further amended to emphasize this homogeneity by reciting the "homogenous" characteristic of the composition in the preamble of the claim. By contrast, the compositions described in US 291 are not homogenous.

US 291 teaches the use of a grafted catalyst on ionic liquids for the polymerization of isobutylene [0009]. Even if the catalyst were soluble in the reaction media by virtue of being

grafted on one of the ionic liquids (which is not described in the examples), nevertheless, neither the isobutylene (starting material), nor the polyisobutene (final compound) are miscible in the ionic liquid used in the example ([EMIM] [AlCl₄]). Indeed, the non-homogeneity is acknowledged by US 291 in paragraphs [0010], [0058] and [0060].

To solve this problem, it is suggested, in US 291, to increase the length of the carbonaceous side chain of the ionic liquids from C10 to C100, in order to obtain a homogenous mixture [0060]. This suggestion is not compatible with the solubilization of isobutylene (starting material) and polyisobutene (final compound) in ionic liquids. The solubility of isobutylene and polyisobutene discussed below:

a) Isobutylene solubility

Ionic liquids with a C10 carbonaceous side chain have their melting point around 0°C (Wasserscheid and Welton, Ionic Liquids in Synthesis, 2008, Vol. 1, pages 67- 69, hereto appended), and isobutylene boiling point is -7°C.

In US 291 isobutylene is used in a liquid state.

Up to -7°C isobutylene is liquid and the ionic liquid (supposed to solubilize the isobutylene) is solid, between -7°C and 0°C isobutylene is gaseous and the ionic liquid (solubilizing the isobutylene) is solid, and at 0°C isobutylene is gaseous and the ionic liquid (solubilizing the isobutylene) is liquid.

Thus, one would not have simultaneously isobutylene in a liquid state and the ionic liquid (solubilizing the isobutylene) in a liquid state.

b) Polyisobutene solubility

The solubilization of polyisobutene (the reaction product) is an even more complex issue. Due to its molecular structure, it would require an ionic liquid with a carbonaceous side chain even longer than the one required for solubilizing isobutylene, which would imply an ionic liquid with a melting point higher than that of the ionic liquid required to solubilize isobutylene.

Ionic liquids with a C18 carbonaceous side chain have their melting point in the range of 200°C, and the melting point of an ionic liquid increases with the length of its carbonaceous side chain (Wasserscheid and Welton, Ionic Liquids in Synthesis, 2008, Vol 1, pages 67- 69, hereto appended).

For safety reasons, a reaction temperature so high is totally incompatible with the use of volatile flammable organic compounds (isobutylene). Furthermore, the chloroaluminates would not be stable under these harsh conditions.

Thus, the reaction of olefin polymerization in ionic liquid described in US 291 could not be homogenous.

In conclusion, i) the catalyst function described in US 291 could not be considered similar to the claimed F_0 group involved in the present invention, and ii) there is no hint nor suggestions to achieve an homogenous composition of a functionalized ionic liquid in a matrix of ionic liquid on the basis of the description and examples of US 291.

Therefore, for the reasons discussed above, ionic liquids described in US 291 fail to provide the same features as recited in claims 114 and 124, and US 291 cannot render obvious the claimed invention.

As further evidence of non-obviousness, the Examiner's attention is respectfully directed to the Declaration Under Rule 132 in the Appendix of this amendment.

The declarant is Pr. Marc Lemaire, Professor at the University of Lyon I, France. A curriculum vitae of Pr. Lemaire is provided. Pr. Lemaire declares that the claimed invention is a major breakthrough. It should be emphasized that, contrary to the observations made in the Official Action, the claimed invention is not considered to fulfil a long-felt but unmet need in relation to a known problem in the art, as much as it opens up a new field of application that was not foreseen in the art.

Therefore, in view of the above, it is believed to be clear that US 291 does not render obvious claim 114-126, and withdrawal of the rejection is respectfully requested.

Claim 113 was rejected under 35 U.S.C. 102(b) as being anticipated by the article by FRAGE-DUBREUIL et al. ("FRAGE-DUBREUIL") That rejection is respectfully traversed for the reasons that follow.

The Official Action considered that "this article teaches a recyclable ionic liquid salt having a functionalized cation, where the functionalized cation has the claim ability of converting initial functional groups to other functional groups". The Official Action further remarked that "the liquid is soluble in itself and thus has both claimed parts", and that "the reference teaches the claimed composition" (page 5).

Applicants respectfully disagree for the following reasons:

The functionalized ionic liquid used in the article by FRAGE-DUBREUIL is used in a solvent-free system (page 6098 right column, page 6099 left column), and not in combination with another ionic liquid.

The reactions described are performed under microwave irradiation, and such conditions are necessary because of the very high viscosity of the so-called "ionic liquid" which inhibits mass transfer and stirring as well. These conditions are not encompassed in the present application.

No mention is made about the use of ionic liquids in synthesis as a homogenous phase comprising a supporting salt (i.e. the soluble support) solubilized in an ionic liquid matrix.


Thus, the article by FRAGA-DUBREUIL does not anticipate claim 113, and withdrawal of the rejection is respectfully requested.

In view of the amendment to the claims and the preceding remarks, applicants believe that the present application is in condition for allowance at the time of the next official action. Allowance and passage to issue on that basis is respectfully requested.

The Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 25-0120 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17.

Respectfully submitted,

YOUNG & THOMPSON



Robert A. Madsen, Reg. No. 58,543
209 Madison Street, Suite 500
Alexandria, Virginia 22314
Telephone (703) 521-2297
Telefax (703) 685-0573
(703) 979-4709

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APPENDIX:

The Appendix includes the following item(s):

- a 37 CFR 1.132 Declaration
- Wasserscheid and Welton, Ionic Liquids in Synthesis, 2008, Vol 1, pages 67- 69.